EPOC Upstream Mapping Part 2

Ed Boyd, Broadcom

Burst Anatomy

UPSTREAM BURST MARKERS

EPON Review

- The EPON OLT PHY locks to the upstream without information from the MAC.
- The PHY is able to determine 1G or 10G EPON operation by detecting signaling speeds in the preamble.
- In 10G, a start of burst pattern is used to identify the start of the first FEC block.
- In 10G, a end of burst pattern is used to identify the end of the valid data and the burst.
- The start of burst and end of burst are patterns that have a large hamming distance for existing data sequences.

EPON Burst Diagram

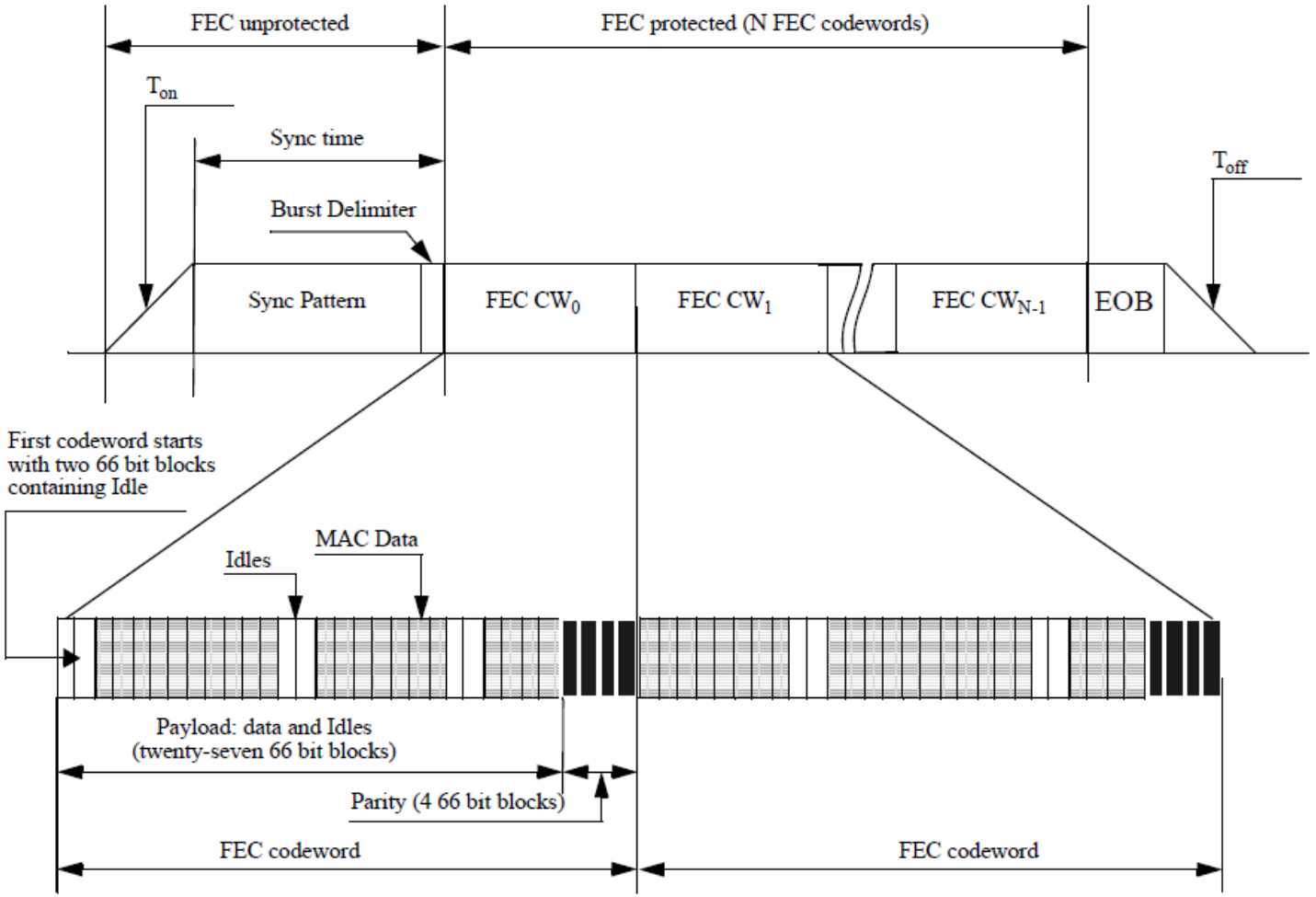


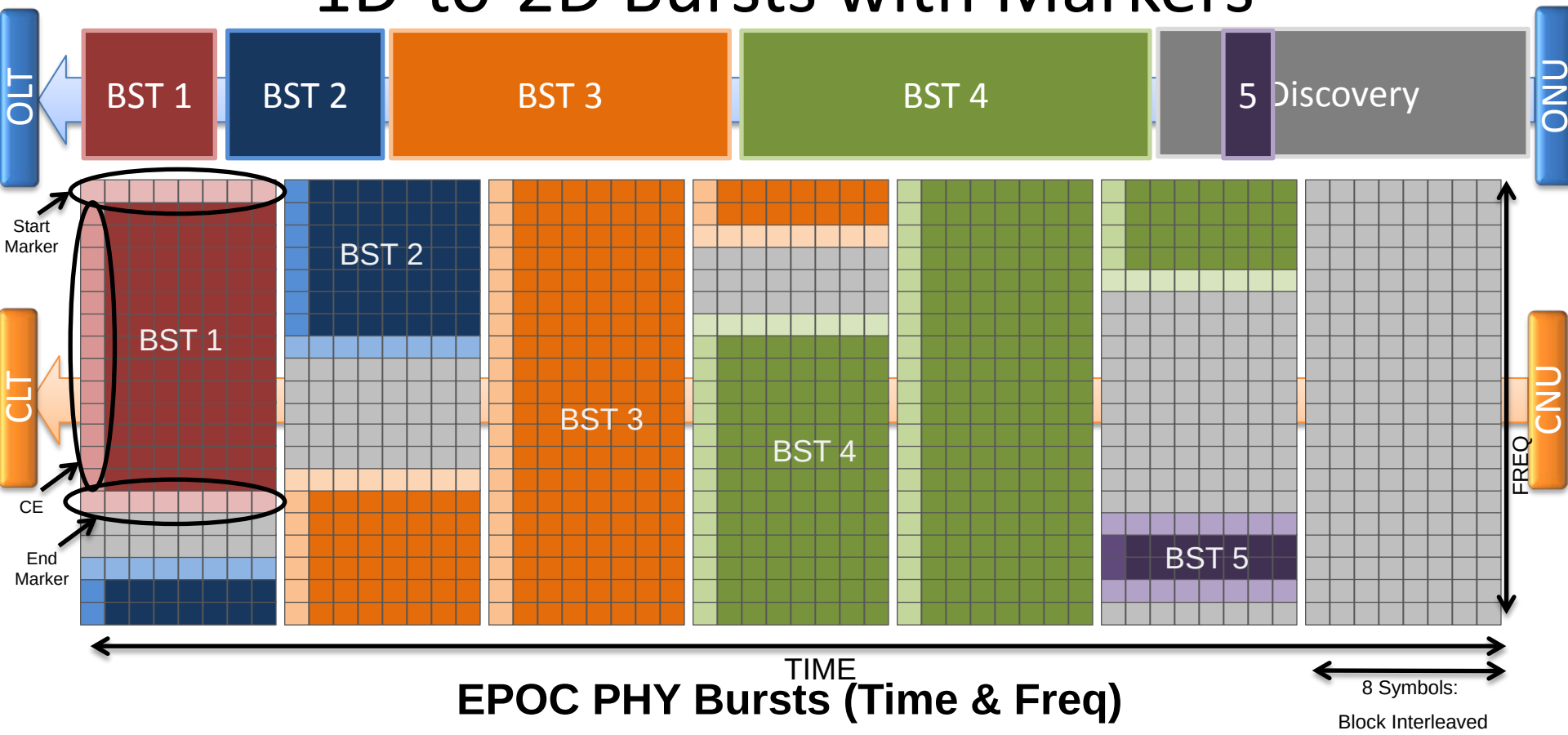
Figure 76–14—Details of burst composition

EPoC to EPON Challenges

- EPON MAC does not have an interface to tell CLT PHY where upstream bursts start and end.
- There is no way to signal the FEC block start and end.
- The EPON MAC upstream can jitter (8 TQ) so it is not always mapped to a known set of carriers.
- Discovery has a random offset in a large window of time.

The EPoC PHY needs a Marker to find burst boundaries

1D-to-2D Bursts with Markers



EPOC PHY Bursts (Time & Freq)

- 1D to 2D Mapping as described in earlier presentations.
- A small number of carriers or symbols are used at the start and end of bursts.
- Markers are a fixed PHY layer pattern that could be detected easily.
- PHY can identify burst start/end and then identify FEC block start / end

Burst Marker Overview

- The exact carrier of a burst start is determined by the “Start Burst Marker”.
- The exact carrier of a burst end is determined by the “End Burst Marker”.
- The number of empty carriers between bursts is unknown due to discovery, idle upstream, or slight upstream jitter in the MAC transmit slot.
- Data from the burst is decoded by FEC decoder and last block size for shortened code word is determined by the end marker.
- Burst Marker Decoding should be simple so it can be done in parallel (on all carriers) before block de-interleaver.

Burst Marker Definition

- Fixed Low Modulation Order Pattern (BPSK?)
- Easy to detect in bad channel conditions
- Simple Hamming Code to fix bit errors?
- Should be able to carry a small amount of data.
  - PHY ID that identifies the modulation profile used.
  - Distinct marker for start and end.
- Multiple Carriers for robustness?
- How can it be unique from normal data?
- Could we use a slightly different Channel Estimation Code to signal the marker?

Burst Anatomy

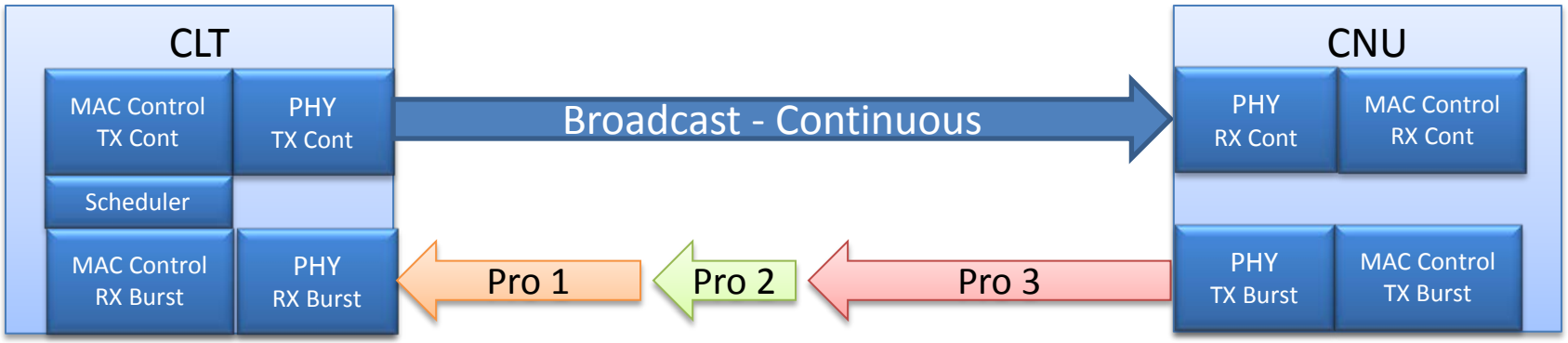
MULTIPLE MODULATION PROFILES

Overview

- These slides describe a solution for multiple modulation profiles (MMP).
- If MMP is determined to be useful, these slides describe a possible solution.
- MMP has implementation, compatibility, and specification challenges on a continuous downstream.
- For this reason, MMP will not be specified for the EPoC FDD downstream.

MMP is significantly easier on a burst interface so it should be considered

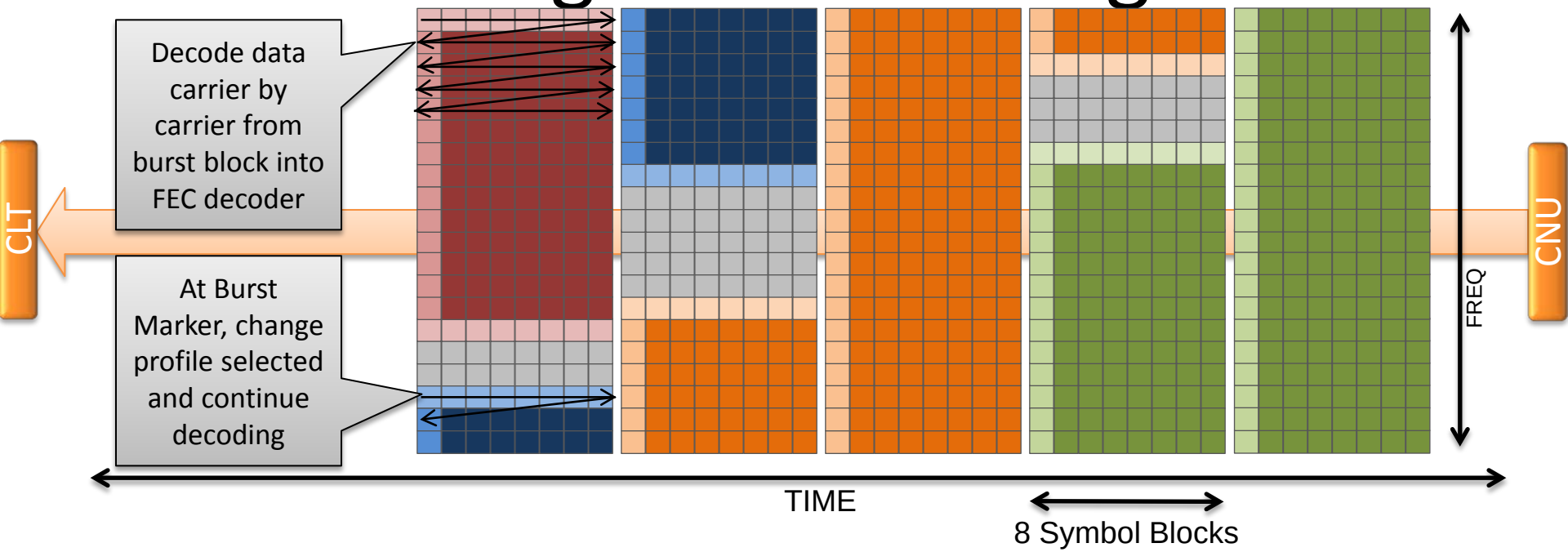
Upstream MMP



- Upstream Bursts contain packets for a single modulation profile since they come from a single CNU. (Packet sorting is not required)
- Upstream Bursts will always end the FEC block so there is no additional penalty for shortened code words.
- Every CNU would store a single modulation profile for the upstream.
- CNUs on different profiles would have a different conversion equation from Byte to TQ. Only one conversion needed.
- CLT PHY needs to detect and decode multiple profiles.

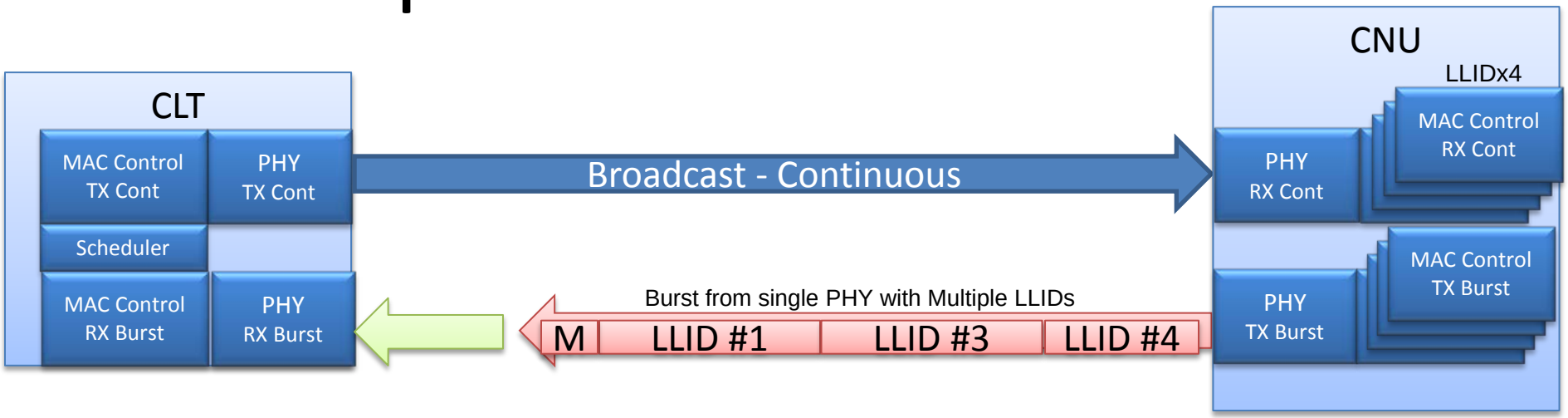
CNU PHY should be simple, CLT PHY is more complex

Detecting and Decoding MMP



- Upstream Burst Markers could contain a small amount of information (2 bits or 1 byte?) that identifies the modulation profile.
- CNU PHY adds Burst Marker with configured profile (Constant data per CNU PHY, no need for delay to add to the front of burst)
- CLT PHY decodes Burst Marker to select one profile from table.
- CLT PHY continues to use profile until next Burst Marker.

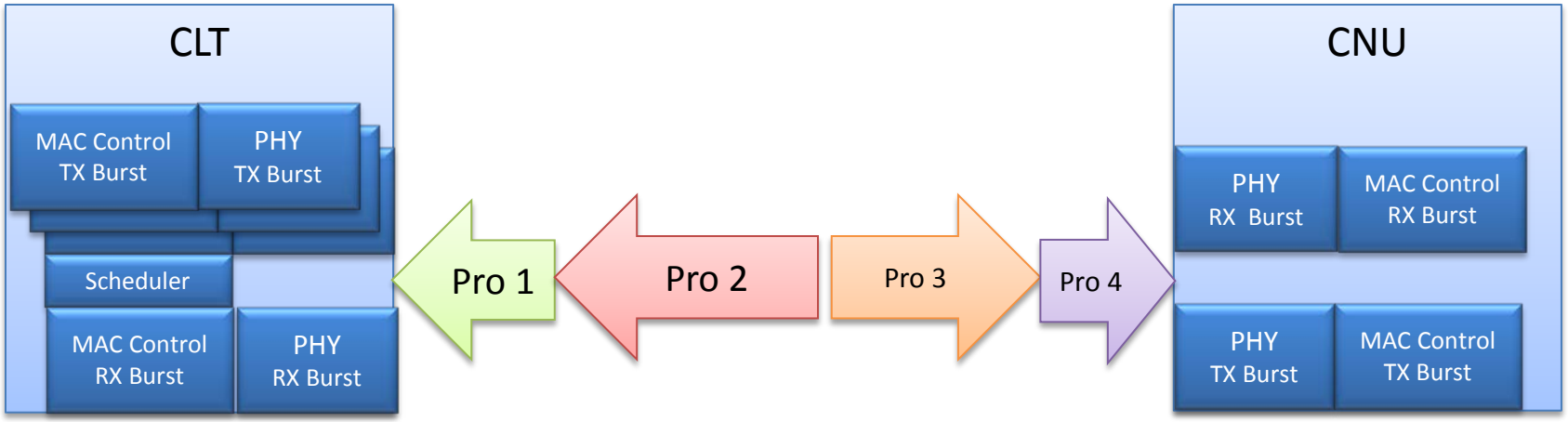
Multiple LLIDs and EPoC Bursts



- Multiple LLIDs on an EPON ONU share a single optical transceiver.
- Multiple LLIDs on a CNU should share a single EPoC PHY.
- Every LLID is a unique MAC Control Client but they should merge to a single XGMII interface and share a single EPoC PHY.
- Multiple LLIDs would use the same burst profile (per CNU PHY not LLID)
- Multiple LLIDs could share the same upstream burst if CLT GATEs are close enough.

Multiple LLIDs can be efficient and transparent to the EPoC PHY

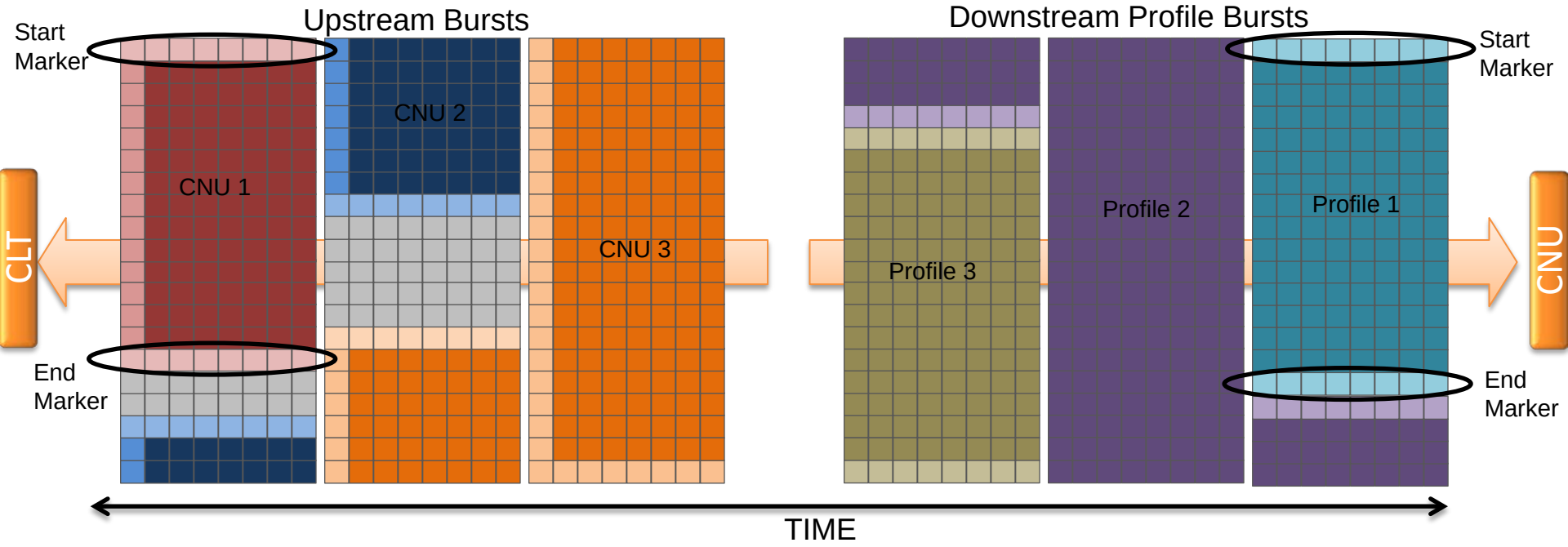
TDD MMP



- TDD uses the EPoC Burst PHY for both upstream and downstream.
- Upstream FDD methodology could be applied to both TDD upstream and downstream.
- Downstream TDD could be represented as a logical MAC & PHY for each modulation profile.
- CLT Scheduler will schedule upstream bursts for each CNU and downstream bursts for each profile (group of LLIDs).
- CNU will need to decode 2 profiles in the downstream

Burst PHY MMP should work for TDD

TDD Downstream



- Upstream Burst Markers are used in the downstream to define profile boundaries for Downstream Profile Bursts.
- Downstream Profile Bursts could be scheduled without upstream guard band between bursts.
- As an optimization, a back to back “End Marker” and “Start Marker” could become a single “Start Marker”.

Summary

- Markers provide a simple method to identify burst starts, burst ends, and profiles in the PHY receiver.
- The same method could be used for all modes of the EPoC Burst PHY: FDD Upstream, TDD Upstream, and TDD Downstream.
- Many more details need to be worked out but MMP seems feasible if required for burst PHY operation.